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Taxonomical revision of the Late Würm *Sorex* (Mammalia, Insectivora) remains of Hungary, for proving the presence of an alpine ecotype in the Pilisszántó Horizon

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(with 2 figures, 1 table and 1 plate)

Abstract

Fossil bone assemblages of 14 localities, ranged in the Pilisszántó Horizon (Late Würm), are stored in the collection of the Geological Museum of Hungary and Hungarian Natural History Museum. *Sorex araneus* findings were reported from five of them (Balla Cave, Bivak Cave, Peskő Cave, Petényi Cave, Pilisszántó Shelter). Taxonomic revision of *S. araneus* showed that several specimens belong to *S. alpinus* in Balla Cave and Petényi Cave. The presence of this form, supported by other Boreo-Alpine fauna elements, indicates not only a significantly cold climate in the Pilisszántó Horizon, but the development of a special ecotype in the named localities. However. as the sites are only 400–800 m above see level, mountainous relief and periglacial climate yielded open mountain vegetation above the zone of pine forests.

Introduction

The present author formerly studied Soricidae material of the Late Würm Vaskapu Cave in Bükk Mountains, Hungary (MÉSZÁROS, 1999). Beside many *Sorex araneus* and *S. minutus* findings he determined Alpine shrew, *Sorex alpinus* from the fauna. This was the first detailed description of this form from the fossil fauna of Hungary. He declared, that "being two hardly distinguished species, some *S. alpinus* occurrence might have been mentioned in the literature as the very common Quaternary shrew, *S. araneus*" and "this problem needs a comprehensive review in the future".

The fossil fauna of 14 localities were ranged in the Pilisszántó horizon of the Late Würm glacial period by the book of JÁNOSSY (1979) about the biostratigraphy of the Hungarian Pleistocene.

Five of them (Balla Cave, Ballavölgy Cave, Görömböly-Tapolca Cave, Remetehegy Shelter, Peskő Cave) are stored in the Geological Museum of Hungary (GMH). A few

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specimens from Pilisszántó Shelter are also registered here. Among these we could have found *Sorex* remains only in Balla Cave, Peskő Cave and Pilisszántó Shelter samples.

The material of 5 sites (Diósgyőr-Tapolca Cave, Kiskevély Cave, Remete Cave, Szelim Cave, Tarkő Shelter) are registered in the collection of the Geological and Palaeontological Department of the Hungarian Natural History Museum (HNHM), but without *Sorex* occurrence. A few specimens of the fossil fauna of Jankovich Cave are present in the HNHM, but the others are in the GMH. *Sorex* forms could have been determined from Bivak Cave, Petényi Cave and Pilisszántó Shelter in the HNHM collection.

Therefore the present paper discusses the taxonomical revision of the *Sorex* species of Balla Cave, Peskő Cave, Pilisszántó Shelter (GMH), Bivak Cave, Petényi Cave and Pilisszántó Shelter (HNHM) (Tab. 1, Fig 1).

Table 1- *Sorex araneus* and *Sorex alpinus* occurrences in the Hungarian localities from Pilisszánó Horizon. * *S. alpinus* is reported by VÉRTES (1965) from Peskő Cave, but it was not find by this study on the present GMH material from this site. ** after MÉSZÁROS (1999 and 2003).

Locality	Stored in	*Sorex araneus* or *alpinus* occurrence
Balla Cave	GMH	*araneus, alpinus*
Ballavölgy Cave	GMH	–
Bivak Cave	HNHM	*araneus*
Diósgyőr-Tapolca Cave	HNHM	–
Gömböly-Tapolca Cave	GMH	–
Jankovich Cave	GMH, HNHM	–
Kiskevély Cave	HNHM	–
Peskő Cave	GMH	*araneus* (*alpinus**)
Petényi Cave	HNHM	*araneus, alpinus*
Pilisszántó Shelter	GMH, HNHM	*araneus*
Remete Cave	GMH	–
Remetehegy Shelter	HNHM	–
Szelim Cave	HNHM	–
Tarkő Shelter	HNHM	–
Vaskapu Cave	PM	*araneus, alpinus***

Morphological terms and the measurements (in millimetres) are used after REUMER (1984). Abbreviation used in the text and the tables: GMH = Geological Museum of Hungary, HNHM = Hungarian Natural History Museum, PM = Pásztó Museum, Hungary, Nógrád Village, Inv. Nr. = inventory number, I = incisor, A = antemolar, M = molar, L = length, W = width, H = height.

Localities

Balla Cave

The locality is situated in the Bükk Mountains, at about 500 m north-northeast of Balla Hill, near Répáshuta village, at an altitude of 600 m above see level. JÁNOSSY (1979) reported Pilisszántóian fauna in one of the layers of the sediment. Rich and well-preserved *Sorex* assemblage is stored in the collection of the GMH from the site.

Alpine fauna element (VÉRTES 1965):

Microtus nivalis

Sorex species (present study):

Sorex araneus

Sorex alpinus

Bivak Cave

The locality is situated in the Western side of the Pilis Hill, which is the highest top of the Pilis Mountains, about 18 km north-northeast of Budapest, at an altitude of 560 m above see level. The „Cave" is a small, fissure-like shelter, containing layered sediments, which yielded rich Pleistocene and Holocene faunas.

Alpine fauna elements (VÉRTES 1965):

Microtus nivalis

Lepus timidus

Capra ibex

Sorex species (according to the present studies):

Sorex araneus

Remarks: *Crocidura leucodon* occurrences dominate the Soricidae fauna of Bivak Cave. Seven *Crocidura* remains, but only one *Sorex* mandible was found in the fossil sample. The dominance of *Crocidura* indicates warmer and drier climate in Bivak Cave than at other sites. However, all *Crocidura* specimens came from the Holocene layers of the site, while Alpine elements and *S. araneus* were found in the Pleistocene ones.

Peskő Cave

The cave is situated in the Bükk Mountains, as horizontally and vertically very near to the Petényi (Peskő 2) Cave. The remains from the "brick red" and "yellowish" strata of its sediments are determined as Pilisszántóian fauna by JÁNOSSY (1979). Beside many arctic and alpine forms, VÉRTES (1965) reports *S. alpinus* in the fauna. Unfortunately, we have found only one *Sorex* skull fragment in the collection of GMH. The alpine shrew could not present in the sample.

Alpine fauna elements (VÉRTES 1965):

Pyrrhocorax pyrrhocorax

Sorex alpinus

Lepus timidus

Microtus nivalis

Rupicapra rupicapra
Capra ibex
Sorex species (present study):
Sorex araneus

Petényi Cave

The locality is situated in the southern side of Peskő Hill in the Bükk Mountains, about 13 km north-northeast of Eger, at an altitude of 735 m above see level. It is a rock shelter of 13 m length and 8 m width. Five Holocene and one Pleistocene layers were present in the sediments of the site.

Alpine fauna element (VÉRTES 1965):
Microtus nivalis
Soricidae species (this study):
Coicidura suaveolens (H5 layer)
Crocidura leucodon (H5 layer)
Crocidura sp. (H3 layer)
Neomys fodiens (P1 layer)
Sorex minutus (H3 and H5 layers)
Sorex araneus (P1, H3 and H5 layers)
Sorex alpinus (P1 layer)
Sorex sp. indet. (P1, H1, H2 and H5 layers)

Remarks: The fossiliferous layers of the site yielded Pleistocene and Holocene faunae as well. *Crocidura* and *Sorex minutus* are present in the Holocene samples, *S. araneus*, *Sorex* sp. indet. occur in both periods, while the Alpine fauna elements, *S. alpinus* and *Neomys fodiens* were found only in Pleistocene layers.

Pilisszántó Shelter

The rock shelter is situated in Upper Triassic (Dachstein) limestone of the Pilis Hill, in the vicinity of Pilisszántó village, about 10 km north-northeast of Budapest, at an altitude of 423 m above see level. One of the richest cave fauna of the Hungarian Upper Pleistocene was found in this site. The cause of the richness of the faunal assemblage might be that this locality was at the time of deposition superbly suited for human settlement and also for birds of prey and carnivorous mammals (JÁNOSSY 1979).

Alpine fauna elements (JÁNOSSY 1979):
Aquila chrysaetos
Lagopus mutus
Calidris alpinus
Pyrrhocorax graculus
Lepus timidus
Microtus nivalis
Capra ibex
Rupicapra rupicapra
Soricidae species (this study):
Sorex araneus

Sorex sp. indet.

Remarks: all the studied forms came from the Pleistocene "brown clay" layer of the site. In the Holocene sample also *Crocidura* sp. indet. is present.

Systematic description

Classis Mammalia LINNAEUS, 1735
Order Insectivora BOWDICH, 1821
Family Soricidae FISCHER VON WALDHEIM, 1817
Genus *Sorex* LINNAEUS, 1758

Sorex araneus LINNAEUS, 1758
Pl. 1, Figs 1-5

Ecology

S. araneus lives now in a great part of Europe and continental Asia, north of the steppe zone, mainly in the wet-soiled woods.

Balla Cave

Material and measurements
Inv. Nr. V.10146:
skull fragment
left P^4 BL = 1.63, LL = 1.20, W = 1.50
M^1 BL = 1.50, LL = 1.43, AW = 1.60, PW = 1.70
right P^4 BL = 1.55, LL = 1.25, W = 1.78
M^1 BL = 1.53, LL = 1.48, AW = 1.63, PW = 1.70
M^2 BL = 1.25, LL = 1.20, AW = 1.61, PW = 1.45
skull fragment
left P^4 BL = 1.63, LL = 1.22, W = 1.75
M^1 BL = 1.48, LL = 1.43, AW = 1.60, PW = 1.75
right P^4 BL = 1.60, LL = 1.33, W = 1.71
M^1 BL = 1.48, LL = 1.40, AW = 1.58, PW = 1.75
skull fragment
right A^2-A^4, P^4 BL = 1.68, LL = 1.35, W = 1.70
M^2 BL = 1.23, LL = 1.22, AW = 1.65, PW = 1.58
right maxillary fragment
fragmentary I^1 and A^3, P^4 BL = 1.68, LL = 1.35, W = 1.85
M^1 BL = 1.50, LL = 1.50, AW = 1.63, PW = 1.71
M^2 BL = 1.10, LL = 1.31, AW = 1.63, PW = 1.40
right maxillary fragment
P^4 BL = 1.55, LL = 1.25, W = 1.63
M^1 BL = 1.40, LL = 1.38, AW = 1.55, PW = 1.61
BL = 1.25, LL = 1.23, AW = 1.65, PW = 1.40
right maxillary fragment
P^4 BL = 1.61, LL = 1.20, W = 1.60
3 complete left mandibles

1: I_1 L = 4.19, H = 1.05
A_1 L = 1.10, H = 0.80
A_2 L = 1.28, H = 0.93
M_1 L = 1.75, W = 1.03
M_2 L = 1.48, W = 0.98
M_3 L = 1.18, W = 0.68
2: I_1 L = 3.63, H = 1.05
A_1 L = 1.03, H = 0.60
A_2 L = 1.20, H = 0.65
M_1 L = 1.75, W = 0.98
M_2 L = 1.45, W = 0.98
M_3 L = 1.08, W = 0.63
3: I_1 L = 4.06, H = 1.03
A_1 L = 1.10, H = 0.73
A_2 L = 1.25, H = 0.88
M_1 L = 1.75, W = 1.03
M_2 L = 1.50, W = 0.88
M_3 L = 1.10, W = 0.68
2 complete right mandibles
I1 L = 3.97, H = 1.05,
A1 L = 1.18, H = 0.75,
A2 L = 1.05, H = 0.88,
M1 L = 1.63, W = 0.95,
M2 L = 1.38, W = 0.85,
M3 L = 1.05, W = 0.63
2: I_1 L = 3.88, H = 1.00,
A1 L = 1.10, H = 0.98,
A_2 L = 1.28, H = 0.98,
M_1 L = 1.73, W = 0.93,
M_2 L = 1.38, W = 0.88,
M_3 L = 1.05, W = 0.65
left mandible
I_1 L = 3.94, H = 1.03
A_1 L = 0.89, H = 0.70
A_2 L = 1.25, H = 0.98
M_1 L = 1.78, W = 0.98
M_2 L = 1.40, W = 0.90
left mandible
I_1 L = 3.75, H = 0.98
A_2 L = 1.28, H = 0.68
M_1 L = 1.63, W = 0.88
M_2 L = 1.38, W = 0.80
M_3 L = 1.00, W = 0.60
left mandible fragment
I_1 L = 3.94, H = 1.00
A_1 L = 1.03, H = 0.78
A_2 L = 1.25, H = 0.80
M_1 L = 1.63, W = 0.65
M_2 L = 1.38, W = 0.85
right mandible fragment
I_1 L = 3.84, H = 1.06

A_1 L = 1.03, H = 0.65
A_2 L = 1.38, H = 0.88
M_1 L = 1.75, W = 0.95
M_2 L = 1.35, W = 0.88

Inv. Nr. V.10147
complete left mandible
I_1 L = 4.00, H = 1.04
A_1 L = 1.32, H = 0.78
A_2 L = 1.30, H = 0.80
M_1 L = 1.78, W = 1.00
M_2 L = 1.50, W = 0.90
M_3 L = 1.23, W = 0.73

Bivak Cave

Material and measurements – from the yellow-grey layer:
left mandible fragment
A_2 L = 1.36, H = 0.88
M_2 L = 1.45, W = 0.85

Pilisszántó Shelter

(GM) material and measurements – "Magdalenien I layer", Inv. Nr. V.13885: complete left mandible
A_1 L = 1.25, H = 1.00
A_2 L = 1.38, H = 1.08
M_1 L = 1.88, W = 1.00
M_2 L = 1.60, W = 0.88
M_3 L = 0.75, W = 0.68
(HNHM) material and measurements – from the brown clay layer: right mandible fragment without ramus mandibulae
I_1 L = 3.65, H = 0.95
A_1 L = 1.03, H = 0.53
A_2 L = 1.10, H = 0.83
M_1 L = 1.50, W = 0.88
right mandible fragment
M_2 L = 1.29, W = 0.78
2 right mandible fragments without teeth.

Peskő Cave

Material and measurements – Inv. Nr. V.14400:
skull fragment
left P^4 BL = 1.53, LL = 1.13, W = 1,63
M^1 BL = 1,45, LL = 1,38, AW = 1.53, PW = 1.63
M^2 BL = 1.30, LL = 1.29, AW = 1.67, PW = 1.50
right P^4 BL = 4.50, LL = 1.10, W = 1.63
M^1 BL = 1.50, LL = 1.45, AW = 1.50, PW = 1.55
M^2 BL = 1.25, LL = 1.30, AW = 1.53, PW = 1.46

Petényi Cave

Material and measurements – from P1 layer: Inv. Nr: V. 62.654:
left mandible fragment
A_2 L = 1.29, H = 0.95
M_1 L = 1.73, W = 0.90
M_2 L = 1.43, W = 0.79
M_3 L = 1.15, W = 0.68
Inv. Nr: V. 62.655: left mandible
I_1 L = 1.64, H = 1.09
A_2 L = 1.35, H = 0.94
M_1 L = 1.63, W = 0.90
M_2 L = 1.40, W = 0.88
M_3 L = 1.05, W = 0.63
right mandible fragment without ramus mandibulae
I_1 L = 4.06, H = 1.05
A_1 L = 1.20, H = 0.75
A_2 L = 1.48, H = 0.98
M_1 L = 1.63, W = 0.93
M_2 L = 1.33, W = 0.80
M_3 L = 1.05, W = 0.66
right mandible fragment with fragmentary A_2,
M_1 L = 1.63, W = 0.95
M_2 L = 1.38, W = 0.85
M_3 L = 1.05, W = 0.68)
right mandible fragment with fragmentary M_1;
right mandible fragment
M_1 W = 0.95
M_2 L = 1.35, W = 0.85
M_3 L = 1.05, W = 0.63
left mandible fragment
A_1 L = 0.93, H = 0.66
A_2 L = 1.03, H = 0.89
M_1 L = 1.50, W = 0.85
M_2 L = 1.30, W = 0.75
right mandible fragment without the back part
I_1 L = 3.71, H = 1.14
A_1 L = 1.13, H = 0.70
A_2 L = 1.28, H = 0.78
M_1 L = 1.63, W = 0.98
left mandible fragment without the back part
I_1 L = 4.00, H = 0.85
A_1 L = 1.00, H = 0.75
A_2 L = 1.18, H = 0.86
left mandible fragment without teeth;
from H3 layer: Inv. Nr: V. 62.797:
right mandible fragment with
M_3 L = 1.00, W = 0.55

Description

The internal temporal fossa is deep and wide. The upper condylar facet is cylinder-shaped, mesially not protruding. Its length is less than the width of the interarticular area. The tiny mental foramen is situated under the M_1 re-entrant valley or protocone. I_1 is long and tricuspulate. There is a wide cingulum in the lower antemolars and molars. There is only one cusp on the A_1, but A_2 is bicuspulate. Entoconid is separate from entostylid in M_1 and M_2. Hypoconid and entoconid are present in M_3.

Sorex alpinus SHINZ, 1837
Pl. 1, Figs 6-8

Ecology

S. alpinus is limited to European high mountains and in the lower, but wet-climated hills in the surroundings of them.

Balla Cave

Material and measurements – Inv. Nr. V.10146:
complete right mandible
I_1 L = 3.80, H = 1.00
A_1 L = 1.13, H = 0.68
A_2 L = 1.23, H = 0.69
M_1 L = 1.50, W = 0.88
M_2 L = 1.25, W = 0.78
M_3 L = 1.03, W =0.58
left mandible
I_1 L = 3.52, H = 1.00
A_2 L = 1.20, H = 0.70
M_1 L = 1.75, W = 0.95
M_2 L = 1.45, W = 0.88
M_3 L = 1.05, W = 0.75
left mandible fragment
A_2 L = 1.10, H = 0.75
M_1 L = 1.68, W = 0.93
M_2 L = 1.50, W = 0.85
left mandible fragment with eroded I_1,
A_2 L = 1.20, H = 0.85
M_1 L = 1.75, W = 1.10
right mandible
I_1 L = 4.06, H = 1.05
A_2 L = 1.33, H = 0.85
M_1 L = 1.63, W = 0.95
M_2 L = 1.25, W = 0.85
M_3 L = 1.03, W = 0.78
right mandible
I_1 L = 4.00, H = 0.98

A_2 L = 1.20, H = 0.80
M_1 L = 1.55, W = 0.90
M_2 L = 1.35, W = 0.86
right mandible
I_1 L = 4.22, H = 1.13
A_2 L = 1.38, H = 0.88
M_1 L = 1.75, W = 0.95
M_3 L = 1.10, W = 0.63
right mandible fragment
I_1 L = 3.94, H = 1.04
A_2 L = 1.35, H = 0.83
M_1 L = 1.43, W = 0.93
M_2 L = 1.00, W = 0.63
with right mandible fragment
A_1 L = 1.18, H = 0.88
A_2 L = 1.30, H = 0.80
M_1 L = 1.60, W = 0.90
M_2 L = 1.28, W = 0.84
right mandible fragment
M_1 L = 1.75, W = 0.95
M_2 L = 1.35, W = 0.83
edentulous right mandible fragment,
Inv. nr. V.10146, in a separate vial: complete right mandible
I_1 L = 4.00, H = 1.03
A_1 L = 1.28, H = 0.68
A_2 L = 1.40, H = 0.85
M_1 L = 1.80, W = 0.98
M_2 L = 1.35, W = 0.88
M_3 L = 1.15, W = 0.65
left mandible
I_1 L = 4.19, H = 1.00
A_2 L = 1.25, H = 0.78
M_1 L = 1.68, W = 0,95
M_2 L = 1.55, W = 0.83
M_3 L = 1.05, W = 0.65

Peténvi Cave

Material and measurements - from P1 layer: Inv. Nr: V. 62.10: left mandible fragment without teeth;
Inv. Nr: V. 62.655: right mandible fragment
A_2 L = 1.13, H = 0.75
M_1 L = 1.50, W = 0.88
M_2 L = 1.28, W = 0.80
M_3 L = 1.03, W = 0.58
right mandible fragment
A_2 L = 1.20, H = 0.83
M_1 L = 1.45, W = 0.95
M_2 L = 1.35, W = 0.85
M_3 L = 1.05, W = 0.68

right mandible fragment
A_2 L = 1.11, H = 0.75
M_1 L = 1.50, W = 0.90
M_2 L = 1.30, W = 0.86
right mandible fragment
A_2 L = 1.15, H = 0.93
M_1 L = 1.50
M_2 L = 1.30, W = 0.83

Description

The morphology of *S. alpinus* is very similar to that of the previous species, but the upper condyloid facet of processus condyloideus is mesially projecting, the lower one laterally widening. The interarticular facet is quite narrow. A_2 is bicuspid.

Sorex sp. indet. (*araneus* or *alpinus*)
Pl. 1, Fig. 9.

Balla Cave

Material and measurements – Inv. Nr. V.10146:
left maxillary fragment
P^4 BL = 1.69, LL = 1.34, W = 1.90
left mandible
I_1 L = 3.64, H = 0.96
A_2 L = 1.28, H = 0.85
M_1 L = 1.63, W = 0.95
M_2 L = 1.45, W = 0.86
M_3 L = 1.05, W = 0.73
right mandible
I_1 L = 4.19, H = 1.00
A_2 L = 1.35, H = 0.90
M_1 L = 1.68, W = 0.90
M_2 L = 1.25, W = 1.00
M_3 L = 1.03, W = 0.75

Pilisszántó Shelter

Material and measurements - from the brown clay layer:
right mandible fragment
A_2 L = 1.50, H = 0.94
M_1 L = 1.75, W = 1.00
right mandible fragment
M_2 L = 1.20, W = 0.76

Petényi Cave

Material and measurements - from P1 layer: Inv. Nr: V. 62.655:
back part of the left mandible, without condyle;

left mandible fragment
A_2 L = 1.25, H = 0.88
M_1 L = 1.58, W = 0.90
left mandible fragment
A_2 L = 1.29
M_1 L = 1.63, W = 0.95
right mandible fragment
A_2 L = 1.08, H = 0.80
M_1 L = 1.45, W = 0.90
M_2 L = 1.30, W = 0.89
right mandible fragment
A_2 L = 1.41, H = 1.13
from H1-H2 layer: Inv. Nr: V. 62.725:
right mandible fragment without ramus mandibulae
I_1 L = 4.17, H = 0.99
A_2 L = 1.33, H = 0.86
M_1 L = 1.63, W = 0.90
M_2 L = 1.38, W = 0.85
M_3 L = 1.13, W = 0.63
from H5 layer: Inv. Nr: V. 62.31:
left mandible fragment
A_2 L = 1.05, H = 0.95
M_1 W = 0.90
M_2 L = 1.35, W = 0.80
right mandible fragment
M_1 L = 1.58, W = 0.85
M_2 L = 1.38, W = 0.80
M_3 L = 1.08, W = 0.64

Remarks

Because *S. alpinus* and *S. araneus* are very similar form in most of the morphological characters and the measurements, the detailed taxonomical determination was not possible in the case of some fragmentary remains. These specimens belong to *S. araneus* or *S. alpinus*, but without the differential characters, so we determined them as *Sorex* sp. indet.

Discussion

Taxonomy

Measurements of *S. alpinus* considerably overlap those of *S. araneus* (Fig. 1). The two forms can be distinguished by the shorter I^1 talon, the bicuspid A_1, the more posteriorly situated foramen lacrimale and the mesially projecting upper condyloid facet of the Alpine species (UJHELYI 1994). Mainly the processus condyloideus and the number of the cusps of A_1 were useful among the differential characters in the separation of the mandibles of *S. alpinus* and *S. araneus* from the studied assemblages (Fig. 2). Bicuspulate A_1 was well-identifiable mainly in some Balla Cave mandibles.

Well-preserved upper teeth and maxillae were present only in the Balla Cave material. Except for one *S. alpinus* specimen we determined these maxillary fragments as *S. araneus* on the basis of the anterior position of the foramen lacrimale

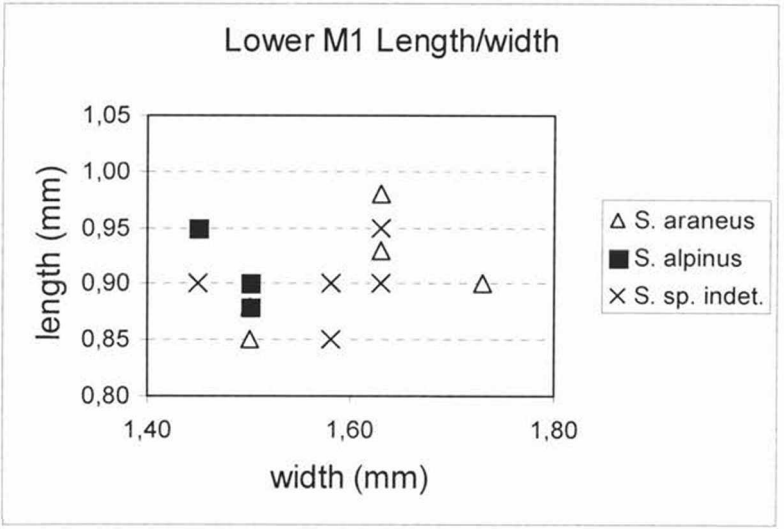

Fig. 1. Scatter diagram of M_1 size of *S. araneus* and *S. alpinus*

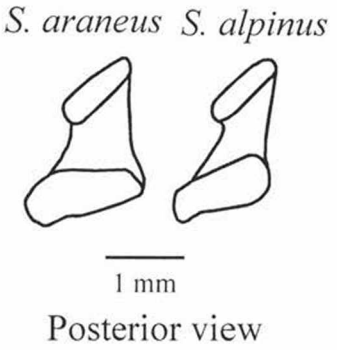

Fig. 2. Differences between the processus condyloideus of *S. araneus* and *S. alpinus* (Petényi Cave, HNHM, Inv. Nr. V.62.655).

Climate

According to REUMER (1984) fossil *Sorex* is indicative for a moist environment with well-developed vegetation. The species recently have a preference for wooded or bushy areas. We therefore assume a humid environment with a good vegetation cover in the time of the deposition of the Balla Cave, Bivak Cave, Peskő Cave, Petényi Cave and Pilisszántó Shelter sediments.

According to JÁNOSSY (1979) Pilisszántó Horizon was the last cold period of the Pleistocene. This is supported by generic composition of the studied samples. During the cold episodes of the Pleistocene the shrew fauna of Europe was dominated by the genus *Sorex* (RZEBIK-KOWALSKA 1975). All of the studied faunae include other indicator species of cold climate (JÁNOSSY 1979). According to JÁNOSSY (1979) this cold period in Hungary was characterized by a fauna reflecting the climate of the boundary zone between tundra and taiga of today.

Ecotype

Sorex alpinus was present in Balla Cave and Petényi Cave samples, but in Bivak Cave, Peskő Cave and Pilisszántó Shelter material it could not be found by the present studies. This Alpine shrew recently lives mainly in the mountain forests of the high mountains of Europe: Pyrenees, Alps, Balkans, Harz, Carpathians, Sudetenland. Its ecotype today is situated also at higher altitude than 1500 m above see level in the Alps.

Few specimens of *S. alpinus* have been also recently reported in the western frontier of Hungary (UJHELYI 1994). However, considering the reports of VÉRTES (1965) and MÉSZÁROS (1999, 2003) on the Late Würm presence of the Alpine shrew in Peskő Cave and Vaskapu Cave, we know four sure occurrences from the Bükk Mountains. These data suggest that the Pilisszántóian occurrence of *S. alpinus* in the Bükk Mountains was not so sporadic as today in Western Hungary.

By the occurrence of *Sorex alpinus* we can suppose that in the named sites, which are only about in 400-800 m above see level, the mountainous relief and the periglacial climate caused the occurrence of open mountain vegetation. This zone would be very similar to the recent mountain ecotype, which situated in the Carpathians and the Alps above the pine forests. This view is supported by the fact that not even arctic but also typical Alpine species were extremely abundant in the studied faunae.

VÖRÖS (1986 and 1987) gives a finer subdivision for Pilisszántó Horizon (22 000 - 12 000 BP). He names the end of the period (16 000 - 12 000 BP) as Bajót climato-fauna phase. According to his studies occasionally the July mean temperature was not above 12.2 °C in this time. Peskő Cave and Petényi Cave are ranged in this period by VÖRÖS (1987).

Today we can find areas with temperature data like the mentioned ones in the northern side of Europe (at the margin of the Scandinavian Mountain Range) (PÉCZELY 1984). The upper border of the pine forest zone is really in about 500-1000 m above see level in these areas, as we suppose it in the Bükk Mountains during the studied period.

S. alpinus occurrences were found only in the Bükk Mountains, in a relatively small area (its diameter is about 8 km). We suppose, that the hypothetical ecotype was not extensive at the end of the Pilisszántó Horizon.

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Plate I

Figs 1-5. *Sorex araneus* LINNAEUS 1758

1. Condyloid process of right mandible fragment, posterior view, Petényi Cave, P1 layer, V.62.655. (Scale bar = 1 mm)
2. Left mandible, lingual view, Petényi Cave, P1 layer, V.62.655. (Scale bar = 5 mm)
3. Right mandible fragment without ramus mandibulae, buccal view, Petényi Cave, P1 layer, V.62.655. (Scale bar = 5 mm)
4. M_1-M_3 teeth of right mandible fragment, occlusal view, Petényi Cave, P1 layer, V.62.655. (Scale bar = 2 mm)
5. Right mandible fragment without ramus mandibulae, buccal view, Pilisszántó Shelter, HNHM, brown clay layer. (Scale bar = 3 mm)

Figs 6-8. *Sorex alpinus* SHINZ 1837

6. Condyloid process of right mandible fragment, posterior view, Petényi Cave, P1 layer, V.62.655. (Scale bar = 1 mm)
7. Right mandible fragment, with A_2-M_3, buccal view, Petényi Cave, P1 layer, V.62.655. (Scale bar = 3 mm)
8. A_2-M_3 teeth of right mandible fragment, occlusal view, Petényi Cave, P1 layer, V.62.655. (Scale bar = 3 mm)

Fig. 9. *Sorex* sp. indet. Right mandible fragment without ramus mandibulae, buccal view, Petényi Cave, H1-2 layer, V.62.725. (Scale bar = 5 mm)

Plate 1

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